NPS Initiatives in Human Social Culture Behavior (HSCB) Modeling
FY 2010-2011

MOVES

Research and Education Summit

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Dr. Jeff Appleget

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Agenda

- **Irregular Warfare: What is it?**
- **What are the modeling challenges?**
- **NPS-HSCB FY 10 research**
- **Proposed NPS-HSCB FY 11 research**

IW Definition

Irregular warfare. A violent struggle among state and non-state actors <u>for legitimacy and influence over the relevant populations</u>. Irregular warfare favors <u>indirect and asymmetric approaches</u>, though it may employ the full range of military and other capabilities, in order to <u>erode an adversary's power, influence, and will</u>. Also called IW. (JP 1-02)

The focus of IW is the <u>relevant populations</u>, not the enemy's military capability.

Irregular Warfare is Local
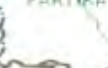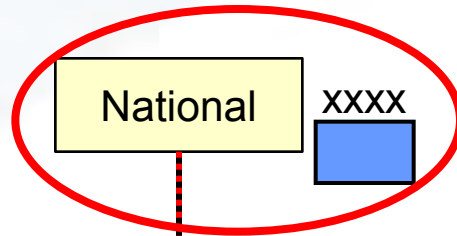
IW operations are necessary when insurgents exert more influence on *local population(s)* than the national government. Setting the conditions to permit national actions to influence the local population is the crux of the IW fight.
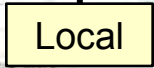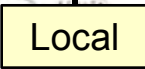
Local populations are influenced by day-to-day interactions with insurgents and the military.

IW Representational Challenges

- **Many theories on individual and group behaviors exist.**
- **Frequently, several different theories describe same phenomena.**
- **Many proposed IW modeling efforts are not well-informed by social science theories or expertise.**
  - **Many IW modeling development teams list no social scientists as team members or even consultants.**
  - **Many IW modeling proposals do not cite any relevant social science theories or models to explain the foundation of their modeling concepts.**
- **Simple Aggregation techniques do not apply to many social science disciplines**
  - **Complicated versus Complex systems.**
  - **Micro versus macro economics.**
  - **Individual versus group behavior.**

Chart from Yuna Wong and Steve Hunt

Military OR	Social Level
Strategic	International
Campaign	Nation
Mission	Community
Engagement	Small Group
Engineering	Individual

Key IW Modeling Tenets

- **Data is the key to developing credible and relevant IW Methods, Models, and Tools (MMT).**

- **Social science models and methods should have accepted pedigree**
  - **widely accepted theory.**
  - **respected journals or a theory endorsed by prominent social science expert(s) in appropriate field.**

- **IW MMT with social science models must be peer-reviewed by an appropriate panel of social scientists.**

- **Programmatics:**
  - **Without exception, models, algorithms and data will be transparent.**
  - **All MMT developed will be government-owned with unlimited rights to maintain and operate.**

Human, Social, Cultural & Behavioral Modeling

Understanding Behavior

Computational Models

Social Network Analysis

Cross-Cultural Training

Vision

Mastery of the social, cultural and cognitive factors that optimize the warfighter's ability to influence human behavior in the full range of military operations.

Mission

Integrated portfolio to study influence of cultural, social and cognitive factors on human behavior, develop data collection methods, build computational models, and validate operationally applicable tools.
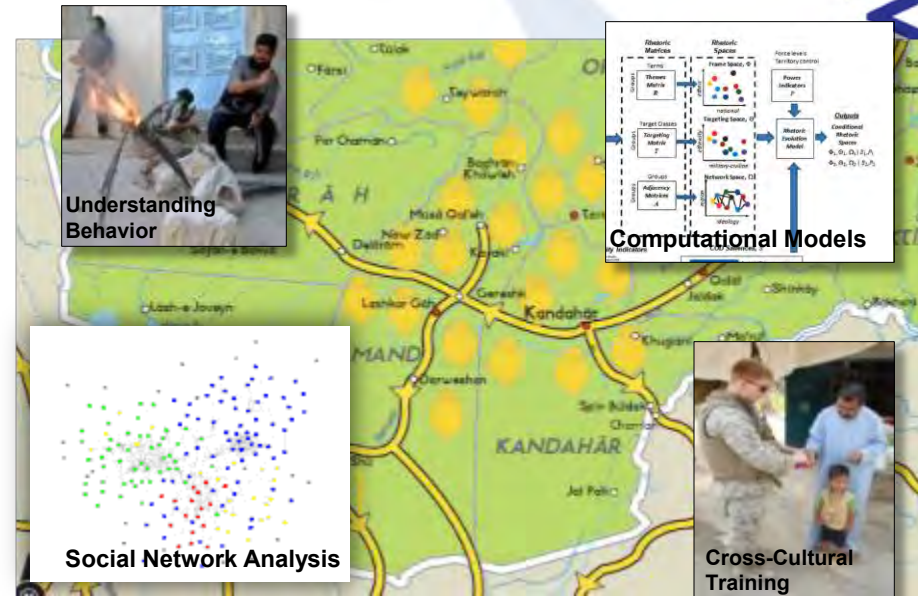
Objective

(1) Advance the state of the art in social science theory to apply to Naval missions and challenges.

(2) Develop methods and tools to enable socio-cultural data collection and generation for a range of mission and environmental conditions.

(3) Provide analysis methods and computational models to support course of action decisions and operational planning.

(4) Produce training and education tools and materials to support cross cultural interaction in support of Naval missions.

Key Research and Technology Investment Areas

(1) Theory and Understanding
(2) Data Generation
  (a) Methods to collect socio-cultural data in new and austere environments
  (b) Methods and tools to generate data
(3) Analytics and Modeling
  (a) Analysis techniques and tools to support decision makers
  (b) Computational Models that incorporate socio-cultural data and knowledge
(4) Socio-Cultural Training & Education
  (a) Methods and materials to support cross-cultural T&E
  (b) Tools for training generalizable cross-cultural skills
  (c) Methods and tools to improve warfighter adaptability in cross cultural

HSCB Program at NPS

Drs Jeff Appleget (OR) and Chris Darken (MOVES)

- **NPS is critical to HSCB vision**
  - **Conducting theoretical and applied HSCB research**
  - **Thought leaders in the HSCB domain**
  - **Investing in HSCB-related labs and tools**
  - **Educating leaders of tomorrow**

- **The program will grow to contain four coordinated, mutually supporting lines of operation:**
  - *Performance* - **NPS faculty are key research performers, contributing to the most complex problems facing DOD for the foreseeable future.**
  - *Education* - **The education of today's and tomorrow's leaders is critical to developing and sustaining DOD readiness to address problems in complex operating environments of the future.**
  - *Assessment* - **As HSCB products are examined and utilized through the assessment process, promising models and tools will be integrated into operational, analytic, and training organizations that could ultimately leverage the products as end-users.**
  - *Transition* - **Transitioning HSCB program products to users is a complementary area where NPS will play a key role. Graduating active-duty students and rotating active-duty faculty provide access to user communities across the services. Additionally, DoD research and thesis relationships with permanent faculty also provide access and feedback to operational commands.**

NPS Unique Qualifications

- **Tightly coupled collaboration between social science, computational science, and warfighting specialties. NPS brings two unique attributes to bear:**
  - **Resident warfighting specialists who bring real world experience to the research topics, and**
  - **Social scientists and computational scientists who work defense-related problems.**

- **Immediate export of HSCB content and findings to officers via educational programs.**
  - **NPS educates military officers who will be the immediate customers for HSCB products.**
  - **Our students serve in Operations Research, Special Forces, Intelligence, Civil Affairs, PSYOPS and Information Operations positions, and many have combat experience.**

- **Unbiased, objective perspective on architectures, protocols, and approaches to HSCB problems. Evaluation of these must be performed by objective personnel who are not driven by profit. NPS researchers and students can provide these services to the program.**

Key NPS-HSCB Program Tenets

- **NPS HSCB research teams consist of modelers, analysts, and social scientists.**
- **Ensure social science conceptual models have adequate foundation:**
  - **Prevailing theory and/or published in reputable journals.**
  - **Peer-reviewed and/or endorsed by prominent social science expert(s) in relevant field.**
  - **Strong basis in obtainable data.**
- **Maintain open and transparent Methods, Models, and Tools (MMTs), algorithms and data to promote sharing, vetting and more rapid progress.**
- **Ensure MMT capabilities are government-owned with unlimited rights (vice exclusive rights) to maintain, share and operate.**
- **All MMT developed must identify data requirements and sources.**
- **All MMT developers will seek to leverage or enhance existing HSCB or DoD modeling initiatives where appropriate.**

Ultimate Goal: Conduct Research that directly advantages one or more of the Combatant Commands

NPS HSCB Program (FY10)

- **FY 10 program focused on Education and Performance.**

- **Task areas being pursued at NPS were developed using solicited input from:**
  - **TRAC-Monterey**
  - **MOVES Institute**
  - **Global Public Policy Academic Group**
  - **National Security Affairs Department**
  - **Defense Analysis Department**
  - **Operations Research Department**
  - **Systems Engineering Department**
  - **Business School**
  - **Center for Homeland Defense and Security (affiliated with the NSA Department)**
  - **Defense Resource Management Institute (DRMI)**
  - **Center for Civil Military Relations (CCMR)**

AFRICOM Survey Research & Analysis

Objectives:

- **Use data from social surveys of local populations to help provide insight into complex social dynamics**
  - **How should AFRICOM allocate limited resources most effectively to fight terrorism?**
  - **What are the critical levers?**
  - **Is "common wisdom" supported by data?**

Relevance: For any country that might ask for US assistance, understanding the country's population, to include its culture(s) and the various groups each population supports, will be the key to understanding the type and amount of US support that should be provided.

Sponsor: AFRICOM providing data; proposal to Office of Naval Research (ONR) for FY11 funding to extend work.

Description:

- **Interested in research methods to analyze complex social surveys in support of AFRICOM decision makers**
- **Determining relationships in and actionable information from survey data**
- **Displaying multidimensional survey data to improve insight into survey results**

Project Team: Professor Ron Fricker, current thesis student LT Kevin Moeller

Deliverables and Status: In March 2010, Lt Moeller presented his thesis brief to approximately 30 individuals of various departments and divisions at AFRICOM HQ. Thesis analyzed data from two countries (Nigeria, ??)using logistic regression to identify COCOM actions likely to have most effect on local population attitudes.

Future Research: Given FY11 ONR funding, intend to extend LT Moeller's research to develop methods, tools, and models to assess how strategic engagement plans, concepts of operation and courses of action are perceived by and affect local populations and adversaries. The practical goal is to facilitate an understanding the human terrain in Africa, which will be critical to US engagement strategies that seek to influence operationally relevant populations before military intervention is considered or required.

Utility-based Learning Agents

Helmund Province

Objectives: To explore the use of learning agents within discrete event social simulations in order to improve the usefulness of social simulations as decision aids.

Relevance: The work directly supported the TRADOC Analysis Center – Monterey"s (TRAC-MTRY) Cultural Geography (CG) model"s incremental development cycle and was used during the PAKAF Multi-Level Assessment (ongoing) with results briefed to the ISAF J-2, MG Flynn.

Sponsor: ONR, TRAC-MTRY

Description: The project prototyped utility-based learning agents for use in the CG model, initially as insurgent actors. Following initial proof of principle work demonstrating the usefulness of the approach with a utility function based on a single percept or attribute, the sponsor integrated the code into the main branch of the model. The code was expanded to allow for multi-attribute utility functions, with a proof of principle implementation of the theory of planned behavior being utilized in the current PAKAF analysis as a general approach to action selection by the population agents regarding infrastructure.

Project Team:

- **LtCol. Papadopoulos, GR, MOVES Student.**
- **Dr. C. Darken, MOVES.**
- **LTC Alt, USA, MOVES Student.**
- **MAJ Baez, TRAC-MTRY.**
- **Mr. Yamauichi, R&A.**

Deliverables and Status:

- **Enhanced insurgent representation. Implemented learning based action selection for insurgent forces.**
- **General learning behavior for all agents. Implemented learning based action selection based on the theory of planned behavior for behaviors related to satisfying basic needs.**

Future Research:

- **Explore alternative learning approaches and characterize their use within the CG model.**

- **Explore the application of learning algorithms to belief revision and communication within agent based social simulations.**

Examining the Composition of Violence

Objectives:

Strategically: This course of research explores the evolution of conflict and how insurgents employ different forms of weapons systems over time.

Operationally: This research empirically examines data available to determine possible measures of effectiveness, moving past current attempts to measure „perceptions."

Relevance: Previous studies argue that civilian fatalities follow a power-law distribution, yet more recent evidence casts doubt on these findings. Given that many models assume power-law distribution for fatalities, finding evidence calling this assumption into question would cast doubt on many models claiming to „forecast"violence.

Description:

Examine the Composition of Violence

This project will examine the determinants and composition of violence in Iraq, with specific focus on the determinants of IED violence. We examine whether civilian fatalities adhere to a power law distribution at the national and subnational level in Iraq. We also explore the relationship between violence acts recorded against US forces and reconstruction projects.

Key Participants:
Dr. Robert M. McNab, Global Public Policy Academic Group

Deliverables:

1. **Conduct literature review, gather data Iraq, integrate data**

2. **Analyze trends, perform descriptive statistics, exploratory power law analysis, and time series analysis**

3. **Technical report describing the methodology in detail and the steps to the practical implementation of the composition analysis and forecasting techniques**

Status: Scheduled for completion in FY10

Modeling Social Dynamics in Counterinsurgency Situations

Social Network

Contrarians

Neutrals

Population

Supporters

Government
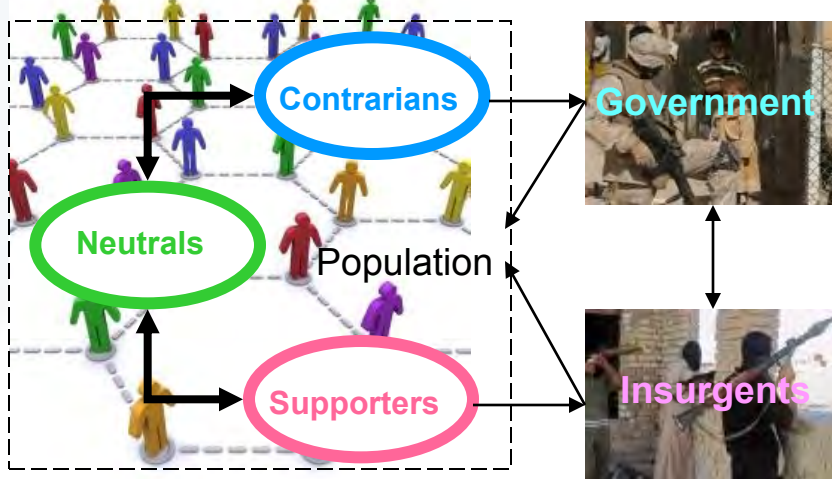
Insurgents

Objectives:

• Develop analytical models for popular behavior in response to the government's and insurgents' actions.
• Examine the effects of benefits, coercion, impositions, situational awareness and collateral damage.
• Identify key patterns, including possible cascading effects, in the behavior of the population in COIN situations.
• Incorporate social dynamics (e.g., social networks) into the analysis
• Derive policy implications for the government.

Relevance:

Results and conclusions from our analysis will provide insight into:
• Which individuals or clans the government forces should attempt to convince to turn against the insurgency.
• What actions the government forces can take to limit the effectiveness of the insurgents' actions.

Description:

To effectively combat insurgents the government forces need intelligence from the population. Therefore we must understand the (in-context) behavioral dynamics of the population in COIN situations. This includes studying the social effects created by the underlying social network of the population. We will develop two families of models – utility and diff. eq. – to capture cause-and-effect relations and possible cascading effects in population behavior. The goal is to produce policy recommendations regarding actions that will shape the population behavior

Project Team:

• Michael Atkinson, Operations Research Department (NPS)
• Moshe Kress, Operations Research Department (NPS)
• Roberto Szechtman, Operations Research Department (NPS)
• Jacob Shapiro, Department of Politics (Princeton)

Deliverables:

 Technical report that contains:
• Model description
• Algorithms for computing dynamic changes in the operational environment state variables
• Guidelines for implementation in larger models.

Status:

• Current utility model in draft version explains why popular behavior may be subject to tipping points as a result of insurgents' and government's actions.

Future Research:

• Develop a differential equation model to study transient dynamics.
• Combine this population-centric model with an attrition model between the government and insurgents.
• Incorporate a strategic population into the model that attempts to extract as much from the insurgents and government as possible.

The HSCB Program at NPS
Modeling the Irregular Warfare Conflict Ecosystem for Combatant Commanders

FY 11 Proposal

1 June 2010

NPS HSCB FY 11 Program Focus

- **OBJECTIVE:** Research, develop and assess methods, models, tools and data that will provide key leaders with the socio-cultural awareness and understanding of the complex conflict ecosystems needed to develop and assess how strategic engagement plans, concepts of operation and courses of action will affect local populations and adversaries.

- **MILITARY RELEVANCE/OPERATIONAL IMPACT:** Leaders at all levels must understand the social and cultural dynamics of the local populations and adversaries unique to their areas of responsibility in order to develop effective plans, operations, and courses of action.

Research and Development Application Areas

- **Understanding the population** – Understand the influences on and behaviors of the population (to include linking actions and events to possible outcomes and effects).

- **Understanding adversaries** – Understand the influences on and behaviors of the adversarial populations (to include linking actions and events to possible outcomes and effects).

- **Understanding data** – Fitting models to, and developing data analysis and visualization tools for, existing operationally relevant data to better understand existing and proposed influences on operationally relevant populations. Understanding survey/polling data, temporal and geo-spatial data are critical need areas.

- **Cultural Training** – Provide cultural training to allow combatants to understand and interact with the relevant local populations effectively.

Proposed FY 11 NPS HSCB Program

Task 1: System Modeling (1 of 2)

- **Task 1.1 <u>The Theory of Fundamental Human Needs: Computational Representation and Integration</u> *(Baez, Gibbons, Perkins)*: This work takes a conceptual model of the Theory of Fundamental Human Needs (Max Neef) and integrates it with the implementation of the Theory of Planned Behavior and the Narrative Paradigm to provide a computational representation compatible with the CG model.**

- **Task 1.2 <u>Understanding the Impact of Perception on the Effectiveness of Information Operations</u> *(Darken, Alt, Gregg, Mahrous):* This research will provide a more robust representation of communication in the dynamic social network by replacing the current simplistic representation of communication with a richer and more fundamental model of communication suggested in cognitive psychology literature.**

- **Task 1.3 <u>Reinforcement Learning Agents for the Representation of Violent Extremist Networks</u> *(Darken, Balogh, Alt, Gibbons):* Reinforcement learning provides a flexible tool to facilitate action selection in agent modeling across multiple domains. By incorporating empirically grounded principles of social influence into the environment portion of the model, we will dramatically improve the realism of the simulation.**

Proposed FY 11 NPS HSCB Program

Task 1: System Modeling (2 of 2)

- **Task <u>1.4 Cultural Geography Lite: For Cultural Modeling, Analysis, and Training</u>** *(Darken, Buss, Alt):* **This task develops a computational tool that will allow commanders and analysts to explore effects of courses of action called CG Lite. CG Lite will facilitate education of both analysts seeking to work with the more advanced CG Model, and the operational community looking for a light-weight, rapidly configurable model suitable for examining courses of actions.**

- **Task 1.5 <u>Geographical Profiling of Insurgents and Insurgent Networks</u>** *(Fox, Blanken, Everton, Jaye, Burks):* **This task will combine geographic profiling techniques developed for modeling criminal activity with cellular automata and agent based modeling techniques to create a model that will geographically profile insurgent attacks and insurgent network locations.**

- **Task 1.6 <u>Operational-Level Modeling of Social Dynamics for Validation</u>** *(Atkinson, Kress, Szechtman, Shapiro):* **This task will research and develop a differential equation model of local counterinsurgency that focuses on selected key factors such as inter-tribal relations (friend/foe) and the insurgents/regime non-violent actions.**

Proposed FY 11 NPS HSCB Program

Task 2: Data Modeling

- **Task 2.1 <u>Methods, Models, and Tools for Analysis and Visualization of Social Survey Data</u>** *(Fricker):* **The overarching research goal is to develop methods, tools, and models that will provide COCOM decision makers with the socio-cultural awareness and understanding of complex north African societies so they can develop and assess how strategic engagement plans, concepts of operation and courses of action are perceived by and affect local populations and adversaries, as well as the ability to predict within a specific degree of certainty the likely response to any given action.**

- **Task 2.2 <u>The Role of Economic and Social Conditions on Violence Generation</u>** *(McNab, Guttieri, Sarkar, Bailey, McGinnis, Wallen):* **This task creates a relatively simple tool to examine the underlying distribution of violence and provide analysis as to whether a steady-state level of violence exists in a specific geographical area. The proposed course of research employs empirical methods from the disciplines of panel data analysis, time series analysis, and statistical inference to examine hypotheses related to the formation and distribution of violence. This research will utilize data from Iraq, and will seek to find similar data from Afghanistan for research purposes.**

Proposed FY 11 NPS HSCB Program

Task 3: Cultural Training

- **Task 3.1 <u>Perceptual learning training strategies for culturally relevant indicators of threat behavior</u> *(McCauley, Alt):* This effort will seek to apply techniques from the scientific literature on "perceptual learning" to identify observable behavioral indicators among individuals in a crowd or on the street that provide information regarding the intention of the individual in question. The goal is to enable Soldiers and Marines to discern ordinary from threat behavior in conflict environments by creating model functionality for integration into a training tool.**

Proposed FY 11 NPS HSCB Program

Task 4: Education

- **Task 4.1** <u>A Systems Engineering Approach to Modeling Littoral Nigeria's Human Terrain</u> *(Paulo, Appleget):* **This task will leverage a systems engineering group project centered on the Gulf of Guinea region in Africa to research a systems architecture for understanding human behavior.**

- **Task 4.2** <u>Design and Development of Agent-Based Models for Human Behaviors</u> *(Jaye, Blanken, Burks, Nannini, Darken):* **This task provides an overview of modeling social phenomena in general, and focuses on the application of agent-based modeling to human behavior.**

- **Task 4.3** <u>Geo-Spatial Statistics for understanding the Conflict Ecosystem</u> *(Whitaker, Buttrey, Ehlschlager):* **This task builds on the students' extensive background in probability, statistics, and stochastic models to examine geo-spatial phenomena. With this background many of the existing spatial techniques can be examined in greater depth.**

Conclusion

- Initial FY 10 NPS effort ISO OSD HSCB program has been very fruitful:
    - helped to bring several research efforts and researchers from different departments and institutes together,
    - educated social scientists, modelers, and analysts about each other,
    - focused proposed FY 11 NPS effort.

- Looking forward to working on the difficult challenges of the FY 11 proposal.